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⑤筋肉様繊維性食品の製造方法

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明　細　書

発明の名称

筋肉様繊維性食品の製造方法

特許請求の範囲

1. 水畜産動物肉に食塩を添加し、混錬して練肉とし、これを細孔を有するノズルから蛋白変性剤水溶液中に吐出して紡糸し、必要に応じて水洗した後、得られた単繊維を集合して加熱することにより繊維を相互に結着させて繊維性を有する肉塊とすることを特徴とする筋肉様繊維性食品の製造方法。
2. 蛋白変性剤がタンニン類である特許請求の範囲第1項記載の方法。
3. 蛋白変性剤がニコチン酸である特許請求の範囲第1項記載の方法。
4. 蛋白変性剤がエチルアルコールである特許請求の範囲第1項記載の方法。

発明の詳細な説明

本発明は新規な筋肉様繊維性食品の製造方法に関するものである。本発明において「筋肉様繊維性食品」とは、動物肉を再組織化したものであつて、外観上は一定方向に揃つた繊維束状を呈したり、あるいは多方向に乱れた繊維の集合体を呈したりするブロック状形態をなし、かつ食感は筋肉繊維様の繊維感と歯応えを有しており、あらゆる点において動物肉とほぼ同等の塊状食品を云う。

近年各種食用蛋白質を繊維状に紡糸成型して繊維状食品を製造する方法が知られ、得られた繊維状食品はそのまま調理されたり、あるいは加工食品の素材として利用されたりしている。例えば、その単繊維を他の素材と混合接着して再構成し、繊維性肉塊に加工して新しい風味の食品とすることが出来る。

食用蛋白として大豆蛋白の如き植物性蛋白を材料とする場合には、アルカリ解膠・酸凝固法によつて紡糸した単繊維をカゼイン等の結着剤を用いることにより、接着させて、肉塊にすることが知

られ一部実用化されているが、風味、食感、コスト等にやや問題があつて、より優れたものが望まれている現状である。これに対して動物肉蛋白を原料とする場合は各種の紡糸法が提案されてはいるが、いずれも品質面や作業効率面で大きな難点があつて、全く実用化されておらず、ましてやこの単繊維を集合結着させる有効な方法は皆無の状態である。

尚近年魚肉すり身を材料として熱固化した細線状のものを束ねてなる、いわゆるカニ足カマボコが市販されているが、これは大きな平板状カマボコを細線状に切断して作られたものであつて、紡糸法によつて作られたものと全く異なり細線自体が太く、したがつて喫食時の食感もカニ棒肉の繊細な繊維感がなく、カマボコの食感を与え、又細線の集合状態も弱くてバラケ易く、カニ肉の歯ざわりとは異質で、到底カニ肉と同等の筋肉様繊維性食品とは云い難いものである。

かくて本発明は水畜産動物性蛋白を原料として作業性よく紡糸して細い繊維状に成型し、得られた単繊維を繊維状形態を保つようにしかも結着剤を何ら用いることなく、集合結着させて品質面においても動物筋肉と全く同等なすぐれた筋肉と全く同等なすぐれた筋肉様繊維性食品を得る方法を提供することを目的とするものであつて、本発明者らの実験、研究によればかかる目的は、水畜産動物肉に食塩を添加、混練して練肉とし、これを細孔を有するノズルから蛋白変性剤水溶液中に吐出して紡糸し、必要に応じて水洗した後、得られた単繊維を集合して加熱することにより繊維を相互に結着させて繊維性を有する肉塊とすることを特徴とする方法によつて達成されることが見出されたのである。

本発明方法を更に詳細に説明すれば、本発明では各種水畜産動物肉を原料として用いることができる。水産動物肉としては、スケソウダラ、カレイ、サバ、イワシ等各種白身、赤身の魚の肉、コエビ、オキアミ等甲殻類の肉、イカ、アサリ等の軟体動物の肉、更に鯨肉等各種の肉を利用することができる。これらは通常新鮮な又は冷凍後解凍されたすり身又はおとし身状の微細肉として用いられる。畜産動物肉としては牛・豚・馬・羊肉や鶏等各種家禽類の肉を用いられることができる。これらは通常ひき肉として用いられる。

これらの各種水畜産動物肉を適宜1種単独で又は2種以上混合して用いる。その場合、水産動物肉のみ或は畜産動物肉のみ1種単独又は、2種以上混合でもよく、又水産動物肉と畜産動物肉とを混合して用いてもよい。目標とする用途、食感等に応じて適宜材料を選択することができる。

このような水畜産動物肉に食塩を添加し混練して練肉とする。食塩を添加し、混練することにより原料肉中の塩溶性蛋白を溶出させて粘稠な肉糊とさせることができ、糸に引いても切れることなく連続的に紡糸することができる。食塩の添加量は原料肉の重量に対して1～10％、好ましくは2～4％の範囲である。混練はサイレントカツター、擂潰機等通常の水畜産練製品製造時に用いる装置によつて行なうことができる。

食塩を添加し、混練する際、必要に応じ種々の食品添加物を添加することができる。たとえば、コーンスターチ、小麦粉、馬鈴薯等の澱粉類、グルタミン酸ソーダ等各種化学乃至天然調味料、香辛料、香料、色素あるいは油脂、植物蛋白等であり、目的とする食感、特性等に応じて適宜選択して用いられる。含油量を高めたい時には、サラダ油、白絞油あるいはラード等の植物性又は動物性油脂が用いられる。これら各種食品添加物は原料肉に対して30％程度の量加えても繊維状にすることができる。

このように原料の水畜産動物肉に食塩を加え、あるいは必要に応じ更に各種食品添加物を1種又は数種加えて混練して得られた練肉を、真空ミキサー等を用いて脱気すれば気泡の混入なく均質となつて好ましい。次にこの練肉を細孔を有するノズルを通して必要に応じて加圧しつつ、凝固浴中へ吐出する。このノズルとしては内径1mm以下好ましくは、0.05～0.5mmの細孔を有する金属製等のノズルが用いられる。練肉はこのノズルから凝固浴たる蛋白変性剤水溶液中に吐出される。

ここでは蛋白変性剤としてタンニン類、ニコチン酸又は、エチルアルコールを用いるのが好ましく、これを数種組合わせて用いてもよい。タンニン類としてはタンニン酸やタンニン、柿渋・茶渋等天然物由来のタンニンを含むものはすべて用いられ、通常タンニン酸として0.1～20重量％、好ましくは0.5～5.0重量％の水溶液として用いられる。ニコチン酸は0.2～10％、好ましくは0.5～1.5重量％エチルアルコールは59重量％以下、好ましくは10～40重量％の水溶液として用いられる。蛋白変性剤水溶液がこれらの濃度範囲より薄い場合には、紡糸成型が不充分となつて良好な単繊維が得られず、更に後の集合結着工程で充分結着しなかつたり、逆に全くゆ着してしまつて一体化し、繊維感のない均質なカマボコ様の肉塊となる。一方濃度が濃すぎる場合には、単繊維の変性凝固が過度に進んで、集合結着しないものとなつたり、集合結着しても食味や食感が著しく悪いものになる。

この蛋白変性剤水溶液は通常常温で用いられるが、必要ならば加温してもよい。ノズルから吐出された練肉は、この水溶液中で表面の蛋白質が速かに変性硬化し、通常1秒～3分間で紡糸成型されて取り出される。より硬くしたいときにはこの水溶液中での浸漬時間を長くしてもよい。ノズルの太さや吐出圧、凝固浴即ち蛋白変性剤水溶液の種類、濃度、温度、放置時間等紡糸時の各種条件を適宜調節することによつて蛋白変性度合、あるいは生成繊維の強度を調節し、後の集合結着工程の効率化をはかることができる。

このようにして蛋白変性剤水溶液中に吐出されて紡糸成型されて得られた単繊維は次いで必要に応じて水洗され水切りの後、集合して加熱し繊維状形態が残るように結着される。通常一定長さ、一定数の単繊維を束ねた繊維束に集合させ、これをセロハン等の通気性フイルムで包んだり、プラスチック製等の袋中に脱気包装したり、金属性のリテーナー中に入れたりあるいは連続的にロールによつて繊維集合形態を保ちつつ熱水や水蒸気或いは高周波等任意の方法で加熱処理される。この加熱工程によつて、繊維束は結着剤がなくともに繊維同士が集合結着される。

このように単繊維を集合結着させてえられた筋肉様繊維性食品の一例の繊維方向に垂直に切断した断面と繊維方向に切断した断面の顕微鏡写真を第1図、第2図として示す。この写真から明らかなように本発明方法によつてえられた食品では単繊維の形態はそのまま保たれているが、単繊維は、繊維の表面付近と繊維の内部の蛋白変性度が異なり、単繊維としての形態、性質を残したまま、隣の繊維と結着して一体となつており、繊維束からなる肉塊を形成している。又繊維表面付近と繊維の内部の蛋白変性度が異なるが故に、これを結着した筋肉様肉塊は、水畜産動物肉に酷似した組織観像を示すものである。

従つて食しても繊維性の食感があり、スケソウダラ、サバ等の魚肉微細肉を混練してつくつた製品でも、カマボコ等の水産練製品様の食感ではなく、魚肉、畜肉、カニ肉、ホタテ貝柱肉等にそれぞれよく似た繊維性筋肉様の食感を与える。なお本発明では、紡糸成型して得られた単繊維を、一方向に集合結着するのみでなく、多方向に集合結着することもできるのであり、この場合も本発明の範囲内に含まれる。

このように本発明方法によつて水畜産動物肉を繊維状に紡糸し、これを集合結着させて再構成することによつて筋肉様繊維性の食品が得られるのであるが、本発明による動物蛋白の紡糸法そして結着法は従来法に比較して次のように多くの利点を有するのである。まず紡糸するに当つては動物肉に食塩又は、更に添加物を添加、混練して得られた練肉をノズルから凝固浴に押出すのみで紡糸しうるのできわめて簡単で効率的である。調味料、色素、油脂等の添加物を工程の初めに添加混練して調味、着色等をはかることができ、しかもその後の紡糸時にもその内容成分の流出、損失が殆んどなく、又その存在により障碍を来すことなく紡糸することができる。その他中和する必要もなく、少なくとも紡糸工程では、必ずしも加熱を必要とすることなく、手間やエネルギーをかけることな

く紡糸することができる。そして1㎜以下の細くかつ強い単繊維を得ることができる。

更に本発明方法によれば、ノズルから凝固浴に繊維状に吐出して紡糸繊維の変性凝固を部分変性に止めることによつて後工程の集合結着を結着剤を用いることなく単に集合加熱することによつて実施することができて有利である点が最大の特徴である。したがつて結着剤を用いた場合のように結着部分の異味異臭や食感の違和感等が全くなく、動物筋肉に酷似した肉塊が得られるのである。又、凝固浴たる蛋白変性剤水溶液の種類、濃度、温度、放置時間あるいは、ノズルの大きさや吐出圧即ち単繊維の太さ等紡糸時の各種条件を適宜調節することによつて蛋白変性の度合そして生成単繊維及び肉塊の強度、食感を自由に調節し、結着工程の効率化をはかることができる。原料あるいは添加物の種類、配合比の選択によつて種々の食感、風味、性質の製品を得ることができ、又紡糸、結着工程を通して連続的に作業することができる。

このように本発明によれば動物性蛋白を原料として細い繊維状に紡糸し、これを集合結着させることにより、原料蛋白からは期待しえないすぐれた食感を有し、品質面においてすぐれた筋肉様繊維性食品をきわめて作業性よく製造することができるのであり、この種産業に貢献する処大なるものである。

以下に本発明の方法の実施例をあげる。

実施例1

スケソウタラすり身100㎏に食塩2㎏および調味料1㎏を添加して、サイレントカッターにて混練し練肉となし、直径0.4 ㎜の紡糸孔を多数有するガラス製ノズルを通してタンニン酸2％水溶液中に加圧吐出して、30秒間この凝固浴中を移動した後ロールで束ねながら巻き取つた後、この集合繊維束をロールでゆるく加圧しつつ蒸気ボックス中で10分間加熱して、太さ10㎜の筋肉様繊維性肉塊101㎏を得た。これを長さ8㎝に切断して市販のカニ足カマボコと二点嗜好試験法による官能検査を実施した結果、第1表に示されるように本発明品の方が、有意に好まれた。

第1表

	好む人数
市販カニ足カマボコ	1人
本発明例	19人

実施例2

第2表に示す原料配合のものを、サイレントカッターで混練し、真空ミキサーで脱気処理を行なつて4種の加塩練肉を調製した。

第2表　原料配合

	A	B	C	D
スケソウタラすり身	40	70	—	60
サバおとし身	30	26	—	—
豚ひき肉	—	—	40	—
マトンひき肉	—	—	50	30
分離大豆たん白	10	—	—	3
コーンスターチ	3	—	—	3
大豆油	14	—	6	—
食用色素	0.5	0.7	—	0.5
調味料	0.5	0.5	0.5	0.9
食塩	2.0	2.8	3.5	2.6

これらの練肉を直径0.5 ㎜ のノズルから第3表に示すような蛋白変性剤水溶液中に繊維状に押出し、2分後に取り出して軽く水洗し、水切りした後、50ｇあて塩化ビニリデンフイルム袋に詰め装して沸騰水中で20分間加熱を行なつてブロック状肉塊とした。このように調製した肉塊における繊維相互間の結着状態及び肉塊の食感は、第3表の通りであつた。

第3表

蛋白変性剤水溶液		繊維間の結着状態	食感
種類	濃度%	A　B　C　D	A　B　C　D
タンニン酸	1	いずれも繊維性を保つて結着	いずれも畜肉様
ニコチン酸	1	〃	〃
エチルアルコール	15	〃	いずれもカニ、ホタテ貝柱様
対照（水）	−	いずれも繊維性を喪失して完全に癒着	いずれもカマボコ様

表に見られるように、蛋白変性剤としてタンニン酸、ニコチン酸、エチルアルコールを用いると、いずれの加塩練肉からも繊維性のあるブロツク状肉塊が得られこれらは風味も良好であつた。

実施例3

スケソウタラおとし身に調味料2%、食塩3%を加えて真空サイレントカツターで混練脱気した加塩練肉を、直径0.5 ㎜の孔を200個有するプレートから20%エタノール水溶液中に押出し、巻き取りつつ該水溶液から2分間後に取り出した。

次いで水洗した後水切りした繊維束をセロフアンに包んで95℃で10分間蒸煮した。得られた肉塊は軽度に結着した繊維束から成り、ホタテ貝柱肉に類似した好ましい食感であつた。

実施例4

スケソウタラすり身10㎏、サバおとし身5㎏、食塩400g、調味料200g、食用色素1gをサイレントカツターで混練した後、魚肉裏漉機でスジ等を除去し、真空ミキサーで脱気処理を行なつて加塩練肉を調製した。この練肉を直径0.3 ㎜の孔を200個有するプレートから、タンニン酸0.5%を含有する水溶液中（30℃）に繊維状に押出し、連続的に繊維束状として取り出した。なおタンニン酸溶液浸漬時間は1分間となるようにした。水切りした繊維束をポリエチレンフイルムに包んで30分間蒸煮を行ない、繊維相互間がほぼ結着した肉塊15.2㎏を得た。

この肉塊は筋肉繊維束状の構造を有し外観、食感共に畜肉に類似していた。この肉塊を繊維方向に垂直に切断した断面と繊維方向に切断した断面の顕微鏡写真を第1図、第2図として示す。その顕微鏡観察結果でも、畜肉組織との類似性が認められた。

実施例5

豚ひき肉10㎏に食塩150g、調味料222g、香辛料10g、澱粉200gを添加してサイレントカツターにて混練し練肉とした。これを直径0.3 ㎜の細孔を多数有する金属製のノズルを通して、タンニン酸1%ならびにニコチン酸0.5%の混合水溶液中に吐出紡糸し5分後に取り出して軽く水洗したのちチヨツパーで約1㎝長の短繊維とした。次いで3×60×60㎝の直方体リテイナー中に充填して、蒸煮ボツクスにて30分間蒸煮して前記短繊維が多方向に集合結着されたブロツク状繊維性肉塊10㎏を得た。

これを1×3×5㎝の大きさにスライサーで切断し、バツターおよびパン粉をつけてフライにした結果食感および風味ともトンカツと同等のものがえられた。

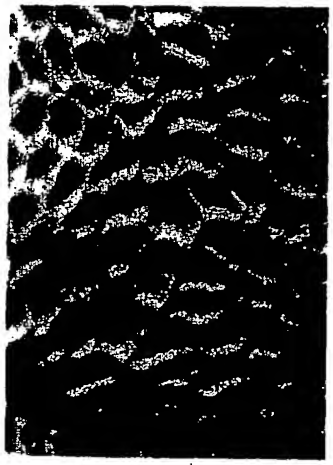
図面の簡単な説明

第1図は本発明の実施例4でえられた筋肉様繊維性食品の繊維方向に垂直に切断した断面の顕微鏡写真（倍率30倍）、第2図は前記食品の繊維方向に切断した断面の顕微鏡写真（倍率15倍）である。

出願人代理人　　鈴　股　　　清

特開昭57-8761(6)

第1図



第2図

手続補正書

昭和55年8月22日

特許庁長官　川原能雄殿

1. 事件の表示

昭和55年特許願第82285号

2. 発明の名称

筋肉様繊維性食品の製造方法

3. 補正をする者

事件との関係　特許出願人

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5. 補正命令の日付

~~昭和　年　月　日~~

~~(発送日昭和　年　月　日)~~

6. ~~補正により　する発明の数~~

7. 補正の対象

明細書中「発明の詳細な説明」の欄

8. 補正の内容

(1) 明細書4頁3行「全く同等なすぐれた筋肉と」を(重複のため)削除する。

(2) 5頁9行「目標」を「目的」と訂正する。

(3) 8頁13～14行「水切りの………される。」を「水切りした後、得られた単繊維を集合して加熱することにより繊維を相互に結着させて繊維性を有する肉塊とする。」と訂正する。

(4) 9頁4行「一例の」を「一例として」と訂正する。

(5) 14頁5行左端「奏し」を削除する。

(6) 15頁第3表タンニン酸の列の繊維間の結着状態の欄中「繊維性を待つて」を「繊維性を保つて」と訂正する。

(11) Patent publication No. 57-8761

(43) Publication Date: January 18, 1982

(54) METHOD FOR MANUFACTURING MUSCLE-LIKE FIBROUS FOOD

(21) Application No. 55-82285

(22) Application Date: June 18, 1980

(71)Applicant : NIPPON SUISAN KAISH LTD.

SPECIFICATION

Title of the Invention: METHOD FOR MANUFACTURING MUSCLE-LIKE FIBROUS FOOD

Claims

1. A method for manufacturing muscle-like fibrous food comprising the steps of adding common salt to a aquatic or livestock animal meat, grinding the meat into a paste, extruding the paste through nozzles having a small aperture as fibers which are then allowed to fall into an aqueous solution of a protein denaturing agent, rinsing the fibers with water as needed, gathering the fibers, and heating the gathered fibers to bind them to each other, thereby obtaining a meat lump having a fibrous texture.
2. A method as described in Claim 1 wherein the protein denaturing agent is one chosen from tannins.
3. A method as described in Claim 1 wherein the protein denaturing agent is nicotinic acid.
4. A method as described in Claim 1 wherein the protein denaturing agent is ethyl alcohol.

Detailed Description of the Invention

The present invention relates to a method for manufacturing novel muscle-like fibrous food. The "muscle-like fibrous food" of the present invention is obtained by reconstituting animal meat, has a block-like shape which appears to be composed of fiber bundles in which fibers are arranged uniformly in one direction, or in which fibers arranged in a disordered fashion in multiple directions are gathered together, and has a texture which, when bitten, has the same fibrous texture and resistance to bite as one would have if one bites the muscle fibers of animal meat. The food is essentially equivalent to the muscle fibers of animal meat in all aspects.

Recently, methods have been developed for molding various edible proteins into fibers and processing the fibers into fibrous food, and have been put into practice. The resulting fibrous food may be cooked as it is to be eaten, or used as a material for other processed food. For example, the fibers separated from each other may be mixed and bound with other food materials, to be reorganized into fibrous meat lump having a novel taste/flavor.

When plant proteins such as soybean protein are used as edible protein in the production of fibrous food, a known method consists of treating a protein-rich plant material with an alkali and then with an acid to produce a protein mass, molding the protein mass into fibers, and binding the fibers with a binding agent such as casein, thereby obtaining a fibrous meat-like lump. Some products manufactured by this method have been marketed. However, they are still unsatisfactory in flavor, texture, cost, etc.,

to a greater or lesser degree, and require further improvement. For animal meat-derived proteins, various methods have been developed for molding them into fibers as well. However, all of them have encountered serious problems: some offered products significantly low in quality and others are defective in terms of productivity. There have been no methods heretofore for effectively molding animal proteins into fibers and binding them together to produce fibrous food, much less a method whereby one can provide marketable fibrous food.

Recently, crab-meat-like processed food or so-called crab-meat rods obtained by hardening a fish paste by heating, processing the hardened meat mass into threads, and gathering the threads into bundles, has been marketed. Specifically, the manufacture of this food consists of processing a fish meat paste into a large solid plate, and cutting the meat plate into slender noodle-like threads. In contrast with processed food based on fiber molding, this processed food consists of threads which are comparatively thick, and does not provide a delicate fibrous texture when bitten as one would have if one bites crab leg meat, but rather is resistant to bite as one would have if one bites boiled fish meat paste. Moreover, binding of the noodle-like threads is so weak that the threads tend to separate from each other. Thus, this processed food, although it consists of muscle-like fibers, has a texture significantly different from that of crab leg meat.

In view of this, the object of the present invention is to provide a method for manufacturing muscle-like fibrous food comprising taking proteins derived from the meat of aquatic animals or from livestock meat as a material, efficiently molding the meat into slender fibers, gathering the

fibers, and binding them together without using a binding agent while maintaining the fibrous form of individual fibers, thereby providing muscle-like fibrous food which is excellent as food, being as good in quality as the muscle of the original animal meat. It was found as a result of experiments and research performed by the inventors that this object can be achieved by providing a method comprising adding salt to the meat of aquatic animals or livestock, grinding the meat into a paste, extruding the paste through nozzles having a small aperture as fibers which are then allowed to fall into an aqueous solution of a protein denaturing agent, rinsing the fibers with water as needed, gathering the fibers, and heating the gathered fibers to bind them to each other, thereby obtaining a meat mass having a fibrous texture.

To describe the present invention more specifically, the materials to be used in the inventive method include meat from various aquatic animals and livestock. Suitable materials include, as the meat of aquatic animals, various white and red fish meat from pollock, flatfish, mackerel, sardines, etc., meat of crustacea such as shrimps, krill, etc., meat of mollusks such as squid, clams, etc., and meat of whales. Usually, the meat of aquatic animals may take the form of a paste or fillets prepared from aquatic animals freshly caught or frozen. Suitable livestock meat includes the meat of cattle, pigs, horses and sheep, and of fowl such as chickens. The livestock meat is usually used as ground meat.

The meat may be prepared from one animal alone or two or more kinds of animals in combination: the meat may be prepared from one aquatic animal alone or two or more aquatic animals in combination, or from

one kind of livestock alone or two or more kinds of livestock in combination, or from one or more aquatic animals and one or more kinds of livestock in combination. The meat material may be chosen as appropriate depending on the desired application or texture of the product.

To a meat material chosen as above, salt is added, and the mixture is ground into a paste. The presence of salt and the kneading action cause salt-soluble proteins in the paste to dissolve in liquid, and the paste becomes a viscid mass. Therefore, the paste becomes so resilient that, even if it is molded into fibers, it can withstand the strain imposed during the molding process so that long, continuous fibers can be produced without being broken midway. The amount of salt added is in the range of 1 to 10% with respect to the weight of the meat material, preferably 2 to 4%. Grinding the mixture can be achieved with an apparatus conventionally used in the manufacture of fish meat paste-based products, such as a silent cutter or mixer equipped with a stirrer.

While the meat mass is salted and kneaded, food additives may be added as appropriate. Suitable food additives may include, for example, corn starch, wheat flour, starches such as potato starch, synthetic or natural seasonings such as monosodium glutamate, spices, flavoring agents, pigments or fat, plant proteins, etc. These additives may be used as appropriate depending on the desired texture or properties of the product. If an oil-rich food product is desired, a plant or animal oil such as salad oil, white strained oil or lard may be used. Those food additives may be added at an amount up to about 30% with respect to the weight of the meat material without seriously affecting the resiliency of the meat mass, which

must be sufficiently high for the meat mass to be molded into fibers.

As described above, a meat material prepared from an aquatic animal or animals or livestock is treated with salt and then one or more food additives as appropriate, and is ground into a paste. The paste is preferably milled with a vacuum mixer so that the paste becomes devoid of air bubbles and homogenous. Then, the paste is extruded through nozzles having a small aperture while being pressurized when needed to produce fibers which are then allowed to fall into a hardening solution. The nozzle is made of a metal and has, on its tip, a small aperture with an internal diameter of 1 mm or less, preferably 0.05 to 0.5 mm. The meat paste is extruded via the nozzles as fibers which are then allowed to fall into an aqueous solution of a protein denaturing agent, that is, into a protein hardening bath.

In this embodiment, the protein denaturing agent preferably includes tannins, nicotinic acid and ethyl alcohol. Protein denaturing agents may be used alone or in combination. The preferred tannin includes tannic acid, and tannin derived from any natural sources such as persimmon tannin, tea tannin, and the like. When tannic acid is used, it is usually used as an aqueous solution containing tannic acid at 0.1-20 percent by weight, preferably 0.5-5.0 percent by weight. Alternatively, an aqueous solution of nicotinic acid containing nicotinic acid at 0.2-10 percent by weight, preferably 0.5-1.5 percent by weight may be used. Or when ethyl alcohol is used, an aqueous solution containing ethyl alcohol at 59 percent by weight or lower, preferably 10-40 percent by weight may be used. If an aqueous solution of a protein denaturing agent has a concentration below the above range, molding of the fibers becomes imperfect and the resulting fibers are

so defective that, when the fibers are gathered and bound, their binding will not be sufficiently secure, or conversely they will bind to each other so strongly that they will exhibit a homogenous, chunky texture like boiled fish meat paste, instead of a fibrous texture. On the contrary, if an aqueous solution of a protein denaturing agent has a concentration exceeding the above range, the fibers undergo excess denaturation and harden so strongly that they will not bind to each other and the resulting meat mass will have a disagreeable taste and texture.

Usually, the aqueous solution of a protein denaturing agent is used at normal temperature, but it may be heated as needed. Meat fibers extruded from the nozzles are immersed in the aqueous solution of a protein denaturing agent where proteins on the surface of fibers are rapidly denaturated to become hardened, and the fibers are bound to each other. This fiber molding is usually completed in one second to three minutes. Then, the molded fiber mass is removed. If more hardened fibers are required, the duration of fiber immersion in the solution may be lengthened. The denaturation or mechanical strength of the fibers can be varied as appropriate by adjusting the size of the nozzle aperture and extrusion pressure, and, with regard to the aqueous solution of the denaturing agent, the kind of denaturing agent, its concentration, temperature of the solution, immersion time, etc. can be varied. This may improve the efficiency of the later process of gathering and binding the fibers.

The fibers which have undergone molding and denaturation in the aqueous solution of the denaturing agent are then rinsed with water as needed, and dried. They are gathered and heated so as to become bound to

each other while maintaining their respective fibrous form. Usually, a certain number of fibers having a certain length are gathered and bound to each other to form a bundle, which is wrapped with an air-permeable film such as one made from cellophane, vacuum-packed in a bag made of plastic or the like, transferred to a metal retainer, or processed into a series of rolls. The resulting meat packs containing the fibrous bundles are subjected to heating treatment based as appropriate on exposure to hot water or hot steam, or to radio waves. The heating treatment causes the fibers to become bound to each other without requiring the deliberate use of a binding agent.

An exemplary muscle-like fibrous food sample obtained by gathering and binding fibers as above was cut crosswise and lengthwise with respect to the longitudinal axis of the fibers, and the photomicrographs of those cut surfaces are shown in Figs. 1 and 2. As seen from the photographs, in the food sample obtained by the inventive method, individual constitutive fibers retain their respective fibrous form, for each fiber the denaturation of proteins on its surface is different from that observed at its center, and individual fibers each retaining their fibrous form and properties are bound to each other to form bundles which collectively form a meat mass. Moreover, since, for each fiber, the denaturation of proteins on its surface is different from that observed at its center, the resulting muscle-like meat mass comprising such fibers exhibits an image, when observed by microscopy, closely resembling that of meat obtained from aquatic animals or livestock.

The food sample obtained by the inventive method had a fibrous texture. Even if the food was obtained from a paste prepared from the meat of fish such as pollock or mackerel, it had a muscle-like fibrillar texture

closely resembling that of meat from fish, livestock or crab or scallop, instead of a texture characteristic of boiled fish meat paste. According to the present invention, gathering of molded fibers may be carried out not only to allow fibers uniformly arranged in one direction to be bundled together, but also to allow fibers running in multiple directions to be bundled together.

As described above, according to the inventive method, meat from aquatic animals or livestock is reorganized: such meat is processed into fibers which are then gathered and bound to produce a muscle-like fibrous food product. The inventive method comprising molding meat proteins into fibers and binding the fibers to each other has the following advantages as compared with the conventional method. First, prior to fiber molding, salt is added to a meat material, which is followed by the addition of an additive or additives. The mixture is ground and the resulting paste is extruded through nozzles into fibers which are immersed into a hardening bath to complete fiber molding. The process is simple and efficient. Since additives such as seasonings, pigments, fat, etc., are added at an early stage of the process, it is possible to properly adjust the taste and color of the product. Loss of and damage to ingredients in the paste during fiber molding hardly occur. The addition of salt and additives does not affect the fiber molding. Furthermore, the fiber molding does not require a neutralization step, and does not necessarily require heating, and thus is economical in terms of labor and time. The fiber molding enables the production of thin, resilient fibers having a diameter of 1 mm or less.

According to the inventive method, fibers extruded from nozzles are allowed to fall into a hardening bath for protein denaturation, but the

duration of fiber immersion in the bath is adjusted such that protein denaturation-based hardening is arrested midway so as to facilitate the binding of fibers which will occur in a later process. This allows the fibers to be bound together in the later process simply by heating without requiring the use of a binding agent. This is the most notable feature of this invention. The product obtained by the inventive method is free from an unpleasant taste, odor or texture which might arise if a binding agent were used, and never fails to exhibit a texture closely resembling that of animal meat. The denaturation of fibers, and mechanical strength and texture of the fiber mass can be varied as appropriate by adjusting, with regard to the aqueous solution of the denaturing agent, the kind of denaturing agent, its concentration and temperature, immersion time, etc., and the nozzle aperture and extrusion pressure, which determine the size of the fibers. This may improve the efficiency of the later process for gathering and binding the fibers. It is further possible to adjust the texture, flavor and properties of products closer to desired levels and qualities, by choosing materials and additives as appropriate, and by adjusting their blending ratios. The fiber molding step and the gathering/binding step may be connected continuously.

As seen from above, according to the present invention, it is possible to efficiently produce, using a material comprising animal proteins, a muscle-like fibrous product having such excellent quality as to exceed any expectation derived from the texture of the original proteins, by processing the proteins into fibers and gathering and binding the fibers together. The present invention will be highly advantageous when applied to industry.

Examples produced by the inventive method will be described below.

Example 1

To 100 kg of sliced pollock meat, 2 kg of salt and 1 kg of a seasoning were added, and the mixture was homogenized with a silent cutter to produce a paste. The paste was extruded under pressure through multiple glass nozzles having a diameter of 0.4 mm into fibers which were allowed to fall into a bath filled with a 2% aqueous solution of tannic acid. The fibers were allowed to move in the bath for 30 seconds, and taken up by a spinning roller to be wound round on its surface where they were gathered and bundled. The fibers, being gently pressed between rollers, were heated for 10 minutes by being exposed to hot steam in a steam box. Thus, a muscle-like fibrous meat mass weighing 101 kg having a diameter of 10 mm was obtained. The meat mass was cut at 8 cm intervals to produce meat rods. The meat rod was used as a test sample. The test sample was compared with a commercially available crab-meat rod (made of boiled fish meat paste) (comparative sample) by means of a yes-or-no preference test (each tester never failed to choose either of the two samples according to his/her preference, and the results were summed for each sample, and the two results were compared). The results are shown in Table 1. The test sample was chosen by testers more significantly positively.

Table 1

	Testers in favor of
Comparative sample	1
Test sample	19

Example 2

Four mixtures having compositions as shown in Table 2 below were homogenized with a silent cutter, and the homogenates were agitated with a vacuum-mixer to remove air bubbles from them. Thus, four salted meat pastes were obtained.

Table 2 Composition of materials

	A	B	C	D
Ground pollock meat	40	70	-	60
Fillets of mackerel	30	26	-	-
Ground pork	-	-	40	-
Ground mutton	-	-	50	30
Isolated soybean protein	10	-	-	3
Corn starch	3	-	-	3
Soybean oil	14	-	6	-
Food dye	0.5	0.7	-	0.5
Seasoning	0.5	0.5	0.5	0.9
Salt	2.0	2.8	3.5	2.6

The four pastes were extruded through nozzles having a diameter of 0.5 mm into fibers which were then allowed to fall into baths filled with different protein hardening solutions as shown in Table 3. The fibers were removed from the bath after a two-minute immersion, rinsed lightly with water, removed of moisture, and divided into 50 g masses, each of which was packed in a bag made of a vinylidene chloride film. The pack was heated by being immersed for 20 minutes in boiling water so that fibers in the pack became bound to each other to form a block-like mass. For each meat pack, the binding of individual fibers and texture of the meat block were examined

and evaluated, and the results were as shown in Table 3.

Table 3

Protein denaturing solution		Binding of fibers	Texture
Solute	Concentration	A B C D	A B C D
Tannic acid	1	Fibers were bound together remaining fibrous-texture in all samples	All resemble livestock meat
Nicotinic acid	1	The same as the above	The same as the above
Ethyl alcohol	15	The same as the above	All resemble crab-meat or scallops
Control (water)	-	No fibrous-texture and fibers completely bound to each other in all samples	All resemble boiled fish meat paste.

As seen from Table 3, when tannic acid, nicotinic acid or ethyl alcohol was used as a protein denaturing agent, a fibrous block-like meat mass was obtained regardless of which one among the four salted meat pastes was used as a material. The meat masses prepared from the four salted meat pastes were all tasty and flavorful.

Example 3

A seasoning and salt were added to the fillets of pollock at 2% and 3%, respectively, and the mixture was homogenized in a vacuum-chamber equipped with a silent cutter to remove air bubbles. This salted meat paste was extruded through a plate having, on its surface, 200 apertures with a diameter of 0.5 mm, into fibers which were allowed to fall into a bath filled with a 20% aqueous solution of ethanol. The fibers were removed from the bath after a two-minute immersion, to be wound round a spinning roller.

Then, the fibers were rinsed with water, removed of moisture, the thus obtained fiber bundles were wrapped with cellophane film, and the resulting pack was steam-heated at 95°C for 10 minutes. The pack contained a meat mass comprising fiber bundles in which the fibers were lightly bound to each other, and had an agreeable texture resembling that of the eyes of scallops.

Example 4

To 10 kg of sliced pollock meat and 5 kg of fillets of mackerel, 400 g of salt, 200 g of a seasoning, and 1 g of a food dye were added, and the mixture was homogenized with a silent cutter, then the paste was passed through a strainer to remove cartilage and the like. The resulting paste was homogenized in a vacuum-mixer to remove air bubbles. This salted meat paste was extruded through a plate having, on its surface, 200 apertures with a diameter of 0.3 mm, into fibers which were allowed to fall into a bath filled with a 0.5% aqueous solution of tannic acid (30°C). The fibers were allowed to move in the solution, and taken up as a continuous fiber bundle. The fibers were allowed to stay in the solution for one minute. The fibers, after being removed of moisture, were wrapped in polyethylene film, and the resulting pack was steam-heated for 30 minutes. Packs weighing 15.2 kg in total were obtained, each of which contained a meat mass comprising fibers nearly completely bound to each other.

The meat mass had a structure like that of a muscle composed of fiber bundles, and closely resembled livestock meat in appearance and texture. A meat mass thus obtained was cut crosswise and lengthwise with respect to the longitudinal axis of the fibers, and the cut surfaces were photographed with a microscope, as shown in Figs. 1 and 2. Inspection of the

photomicrographs also showed that the meat mass has a texture closely resembling that of livestock meat.

Example 5

To 10 kg of ground pork, 150 g of salt, 222 g of a seasoning, 10 g of a flavoring agent, and 200 g of starch were added, and the mixture was homogenized with a silent cutter to produce a paste. The paste was extruded through a metal nozzle having, on its end surface, multiple apertures having a diameter of 0.3 mm into fibers which were then allowed to fall into a bath filled with a mixture comprising a 1% aqueous solution of tannic acid and 0.5% aqueous solution of nicotinic acid. The fibers were removed from the bath after a five-minute immersion, rinsed lightly with water, and cut at regular intervals with a chopper to provide short fibers of about 1 cm in length. The fibers were transferred to a rectangular retainer having a volume of 3 x 60 x 60 cm, and steam-heated in a steam box for 30 minutes. A block-like fibrillar meat mass weighing 10 kg was obtained in which disorderly arranged short fibers were packed and bound to each other.

The meat mass was cut with a slicer into slices each having a volume of 1 x 3 x 5 cm. The slices were coated with butter and breadcrumbs, and fried. The resulting cooked slices were equivalent in texture and taste to cutlets prepared from pork.

Brief Description of the Drawings.

Fig. 1 is a photomicrograph (30 times magnification) of a cross-section of a muscle-like fibrous meat product prepared as in Example 4 and cut vertical to the long axis of the fibers. Fig. 2 is a photomicrograph (15 times

magnification) of a cross-section of the same meat product cut in parallel with the long axis of the fibers.

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